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Speech-Language Development: Oral and Written

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The human brain comes wired for language. Under normal development, the brain has a broad-based ability to acquire receptive and expressive oral language followed later by written language. Whatever the particular language a child is born into, the child's brain acquires those specific phonemes and the syllable patterns through which they combine to form words. These phonemes and syllable patterns are thus the foundation for acquiring the morphology, grammar, syntax, and semantics through which the words then form the structure of the language. Under normal development, acquisition occurs simply by having the brain immersed in the auditory input of that language. Considering that there are more than 5,000 languages in the world, this attests to the brain's incredible flexibility and innate capacity for language.

Immersion in language, however, does not result in normal oral language development for an estimated 10% or more of the population; problems in written language development are much higher. The National Adult Literacy Survey (1993) indicated that 48% of the adult population lack written language skills sufficient for the normal requirements of life. This is in spite of those individuals having had opportunities for schooling, with some of them even having college degrees. This chapter provides an overview of what is known about normal oral and written language development, factors that can interfere with that development, current interventions that are proving effective in preventing or remediating speech-language and written language problems, and some questions in need of further investigation.

HIERARCHIES IN ORAL LANGUAGE ACQUISITION

Research and theory on language acquisition have largely dealt with English language learning. Contributions from crosslinguistic study of language acquisition and infant research are broadening our understandings. Although much is still unknown, infant research shows promise of helping to identify predictors of later problems, which could enable intervention to be mounted earlier for preventive action. David Lewkowicz and colleagues with the New York State Institute for Basic Research in Developmental Disabilities have been seeking better understanding of perceptual development in human infants in research spanning more than 20 years. Lewkowicz has particularly focused on how infants perceive the relationship between auditory and visual information within the general issue of intersensory integration. In his most recent work with faces and voices,

Lewkowicz (1999, in press) found that complex relationships are involved in whether infants attend to auditory or visual information, and depend on the specific nature of the information presented. Overall, infants are sensitive to the synchrony of auditory and visual inputs. Lewkowicz (2000) has recently proposed a theoretical model related to responsiveness to the four basic features of multimodal temporal experience; that is, temporal synchrony, duration, temporal rate, and rhythm. Lewkowicz's model proposes that responsiveness emerges in a sequential, hierarchical fashion during the first year of life and that responsiveness to one temporal feature builds on the previously acquired intersensory temporal processing skills. According to Lewkowicz (personal communication), "Much of the support for the model comes from our work showing that infants detect and respond to temporal synchrony relations very early in development, but that they do not begin to respond to intersensory temporal relations based on duration and rate until later in the first year of life." These findings suggest a probable benefit for speech-language development if we make it a point to hold our babies so they have the synchrony of visual input from our faces with the auditory input from our voices as we talk to them.

Slobin (1997) has also been researching speech and language development for more than 20 years. He has led the way in identifying additional universals in language development through crosslinguistic studies. Slobin's view of language acquisition has evolved. Initially skeptical regarding an innate structure for language, later he recognized "strongly inbuilt tendencies to analyze speech into certain types of units, and to systematize and interrelate and cross-classify these units in highly specific ways" (Slobin, 1985, p. 1244). His current view is that there are *"indications of accessibility hierarchies and individual differences which are based on independent cognitive or processing variables rather than on linguistic features across languages"* (Slobin, 1997, p. 452, italics added). We at Lindamood-Bell Learning Processes strongly agree with Slobin's current view. Our clinical and classroom experience and research definitely validate his position that it is not the linguistic features of languages that cause differences in how children access the hierarchies of developmental progression, but that the differences are due to individual variations in sensory or cognitive processing abilities. In approaching children with a wide range of special needs, including speech and language, Greenspan and Wieder (1997) have provided a Developmental, Individual Differences, Relationship-based (DIR) intervention model with this same basic philosophy: that individual differences in each child's functional developmental profile and the ability to interact with the sensory world, form emotional and interactive relationships with people, and cognitively connect to incoming sensory information are what should drive our intervention, not the child's chronological age (see Chapter 3 for further discussion of the DIR model). In their model, the age-appropriate interactions known as floor time set the tone for this philosophy of intervention. Floor time begins at the basis of communication; that is, emotional and interactive relationships between child, parents, and other caregivers.

PROGRESSIONS IN NORMAL SPEECH-LANGUAGE DEVELOPMENT

Vowels, Consonants, and Babbling

Under normal patterns of acquisition, there is a normal range of individual differences in how early speech-language emerges.

However, the development of spoken language follows a hierarchy of progression in its emergence, and that hierarchy is essentially the same across languages, regardless of the final form of the specific language. For example, in all languages, infants produce isolated vowel and consonant phonemes very early. The child, however, experiences several months of receptive language input before combining consonants and vowels together repetitively to produce simple syllables in the vocal play called babbling. Babbling, and the extension of this play with nonsense syllables into chants, rhymes, and songs by older children and adults, occurs in all known languages and tells us the human mind finds this play with syllables pleasurable. There is even a core of same-syllable configurations involving the same phonemes that occurs across many languages.

Single Words

Single words are the next step in the progression, and here the linguistic environment can have an effect. For example, nouns for names of people and things are stimulated and acquired first in English, but verbs are stimulated and acquired first in Japanese (Clancy, 1985) and in Mandarin Chinese (Tardif, 1996). Choi noted that verbs are acquired first in Korean, and reported a connection between language and cognition because her data indicated form-function relationships were attended to as early as first words (Slobin, 1997). The senior author of this chapter also observed this on the second morning of a car trip from New York to California. As her 9-month-old son awakened in a hotel room again, he looked around wonderingly and asked, "Bye-Bye?" His rising inflection clearly indicated he was asking whether he would be traveling again that day.

Interestingly, at 10 months of age, he began forcing the naming of things. When he saw something for which he didn't have a name, he would point and stare intently in its direction while making a radar-type blip sound. As we (his parents) named various things in the vicinity he was indicating, he would shake his head "No" and continue the sound until he was satisfied that he had a name for the object of his interest. Then the sound would stop. This naming demand may have been stimulated by our early efforts to introduce him to language. Starting when he was about 6 months of age, we had expressly given single words for things and actions so that he could experience the beginning and end of a word rather than having those features lost within the flow of a sentence. During his babbling period, we had also enjoyed an interaction with him that increased and varied his babbling. For example, after he said "ba,ba,ba" we repeated it, and then he said it again. When this interaction was set, we imitated the babbled pattern a second time but varied the final syllable as in "ba,ba,ga" or "ba,ba,da" to see if he would perceive and produce the change. He could and did, after a short transition period when he just accepted the second stimulation receptively for a period before he began to imitate the variation.

The progression from isolated sounds to the syllable play of babbling to meaningful single words will, of course, occur normally without the interactive stimulation just described. However, many real words in our language are composed of only two sounds: a vowel/consonant (VC), that is, eat, in, out, up, on; or a consonant/vowel (CV), that is, go, bye, see, pie, no, and so on. When imitative interaction is established during babbling with these simple syllables, it facilitates the early acquisition of a vocabulary of similarly structured real words and

empowers children to become early active communicators in their world.

Jargon

Just before or during the period when single words are first beginning to emerge, standard descriptions of language development cite a *jargon period.* This is when children express long strings of syllables inflected in the normal rhythm and prosody of sentences. The jargon period is referred to as a necessary and normal stage in speech and language development, but it can be a frustrating period for parent and child. The child appears to be communicating an idea or a request, but the parent cannot understand it because no single word is discernible. There is a possibility, however, that this frustrating jargon period could be avoided and does not have to be a step in "normal" development. For example, when my child forced the extensive single-word naming, he acquired sufficient words to go easily into phrases and sentences, thereby bypassing the jargon period. On the basis of that experience, the same babbling intervention and extensive single-word naming were provided to two more sons and a daughter, and the same phenomenon occurred. None of them experienced a jargon period. They bypassed it and went from intelligible single words to intelligible phrases and sentences. Although this is only anecdotal information, it would appear a pilot study is warranted with a formal experimental and control group design to explore whether the effect of such intervention can be replicated and jargon bypassed. Data from intervention research indicate that environmental variables can influence infant vocalization and later phonological development (McReynolds, 1978).

Milestones

The following developmental milestones in speech-language acquisition were summarized by Berry (1969), although there can be wide individual variation. In general, the timing occurrence of Berry's milestones has not changed appreciably in the years since that initial analysis, judging by the work of Rescorla (1989). These milestones follow.

- With the single-word receptive and expressive vocabulary developing steadily in the period between 1 and 2 years, a child normally develops a minimum 50-word vocabulary and combining of words into phrases between 18 and 24 months.
- A child will normally progress to short sentences before 30 months of age. By 36 months, a child can structure sentences as questions, and most sentences involve three or more words. Speech is fairly intelligible, although inconsistent substitutions, omissions, and distortions of consonants will be common.
- Between 3 and 4 years of age, a child makes important gains in phoneme production and accurate articulation of consonants in various positions in words. Omissions and substitutions are significantly reduced, and speech is 90% or more intelligible.
- By 5 years of age, some children will still have problems articulating the consonants /f/, /v/, /th/, /l/, /r/ or /s/. But, since these errors generally do not make speech unintelligible, speech pathologists in school settings tend to wait to see whether maturation will take care of these problems before scheduling these children for speech therapy.
- Between 6 and 8 years of age, a child's speech becomes virtually 100% intelligible. However, about 10% of children may need some assistance in mastering those final, more complex phonemes or in some

aspect of language comprehension or expression. The average sentence involves about seven words, and any grammar irregularities are likely to be related to the child's cultural environment.

In spite of this positive picture for oral language becoming adequate for the bulk of the population during the course of normal development, two major concerns remain. First, the picture for written language development is far different, as cited previously. Also, research has shown clearly that early problems in articulation are predictive of later problems in written language acquisition and that lack of phoneme awareness is a factor in both (Mann, 1993). This suggests that phoneme awareness should be routinely stimulated as a preventive early in speech-language development. Preventive action should also be planned to avoid written language problems by helping all children to develop and consciously connect phoneme awareness to the logic of our alphabet system for success in spelling and reading (Lindamood, Bell, & Lindamood, 1997a). Preventive action is not a waste for those with a genetic predisposition to acquire phoneme awareness; it simply accelerates their development of spoken and written language skill and the benefits and pleasures it provides (Lindamood, Bell, & Lindamood, 1997b).

Second, when vocabulary and syntax are adequate, language comprehension and expression are often also assumed to be adequate. However, data from college and adult populations indicate that significant weakness in language comprehension can persist even into adulthood for significant numbers of individuals. For example, in a recent measure of performance of 60 freshmen Early Education majors on the Watson-Glaser Test of Critical Thinking, 50% of them ranked at the 20th percentile or below. In performance on the Watson-Glaser for 50 primary and secondary classroom teachers, special education, resource, reading teachers, and speech pathologists, 28% ranked at the 25th percentile or below (Lindamood, Bell, & Lindamood, unpublished data). This should be of concern in these training programs because the weakness indicated can be identified and remediated.

PREVENTING ORAL SPEECH-LANGUAGE PROBLEMS

Vegetative Functions

Speech is an overlaid function. The basic functions of the mouth are vegetative and involve sucking, valving, swallowing, and, later, chewing. Thus, the motor coordination of vegetative functions is a base for the motor coordinations of speech. Preventive and remedial intervention should first give attention to the vegetative acts to be certain this base is functional. The mouth at rest should be closed, with the tongue in light contact with the roof of the mouth. If the jaw is slack and the mouth open, the tongue follows the jaw and is pulled away from its normal rest position. We swallow twice a minute. If the tongue is resting down and forward instead of up and in, this encourages a tongue-thrust position in swallowing. The tongue sucks and valves forward rather than taking its normal position against the roof of the mouth, where it forms a peripheral seal while a peristaltic action moves liquids and solids to the back of the mouth for swallowing. When babies are nursed, the mother's nipple flattens between the tongue and the roof of the mouth and facilitates this normal swallowing action. When babies are bottle-fed, long firm nipples that don't flatten can interfere with this normal pattern. The MAWS Feeding Bottle with its VARIFLO nipple and the AVENT Naturally have nipples designed to facilitate

this normal sucking and swallowing pattern and are wise choices. They are both European products, but are available widely in the United States in stores selling baby goods. It is well to avoid the extended use of pacifiers and thumb-sucking because they also interfere with the tongue's normal rest position and action in sucking and swallowing and in speech. With well-coordinated vegetative functions, drooling is controlled, and the use of the tongue, lips, and mouth in articulatory action is facilitated.

Vocal Play

When sensory stimulation is begun by parents and other caregivers through early vocal play, an interactive relationship is established that can continue to develop and be enjoyed throughout the normal emergence and progression of language.

- *The rationale* is language emerges as a result of sensory stimuli. We see, hear, and feel and connect those experiences to form language.
- *The procedure* is to select and intensify the input of sensory stimuli basic to language.

Given the brain's innate tendency to imitate speech, vocal play with babies with individual consonants and vowels can be initiated very early. It is easy and fun to do and to observe their interest and response. For example, if babies are diapered on a counter or changing table, this is an ideal time for vocal play. The adult's face and mouth are above the baby and close enough to give an excellent view of tongue and mouth actions. Another good time is when giving babies a bath, or anytime there can be close physical contact for a few minutes without other distractions. To make tongue actions visible, caregivers should keep their mouth as open as possible. All manner of nonspeech sounds and mouth actions can also be included, such as tongue clucking, lip smacking, lip pursing and blowing, tongue grooving, tongue protrusion, or tongue trilling. Babies only a few months old can imitate tongue trilling. The first indication that they are registering the tongue action is when their tongue tip rises and holds on their upper gum ridge. Some time after that they will produce a trill, matching the trilling input. Because the processing of speech sounds and the human voice occur in different parts of the brain than are involved in the processing of other acoustic signals, it is important to include individual vowel and consonant sounds, too. High and low tonal contrasts should also be offered.

For vocal play with vowels and consonants, the following categories and their labels are suggested from the Lindamood Phoneme Sequencing™ (LiPS™) program (Lindamood & Lindamood, 1998), formerly the Auditory Discrimination in Depth (ADD) program. When the LiPS™ program is used to remediate oral and written language problems with children who can answer questions, its categories are not told; they are discovered through Socratic questioning and problem-solving experiences in analyzing the oral-motor actions that produce individual speech sounds. In preventive stimulation with infants, however, the individual sounds are simply produced in a play routine, twice with exaggerated articulation while the baby is watching, and again after approximately a 3-second pause. No sound imitation occurs at first, but the baby's mouth begins mirroring the stimulus mouth shape. The sensory input provided must be experienced receptively for some time before the brain begins to interact with it. With children between 1 and 3 years of age, the labels for the categories are verbalized during stimulation (i.e., "Watch me make a lip popper - /p/!"). This directs the child's attention to the motor production fea-

tures that distinguish the sounds. The child can also feel the difference between plosive and continuant air streams by having the child feel the air stream on the back of his or her hand.

Vowels

There are four vowel categories, which are labeled for mouth shape. They should be stimulated in the order presented, with the easier ones to imitate given first.

1. Round sounds
   - /OO/ (as in boot)
   - /OO/ (as in foot)
   - /OE/ (as in toe)
2. Open sounds
   - /O/ (as in odd)
   - /AW/ (as in paw)
3. Smile sounds
   - /EE/ (as in eek)
   - /I/ (as in it)
   - /E/ (as in Ed)
   - /AE/ (as in ape)
   - /A/ (as in at)
   - /U/ (as in up)

As imitation occurs on some of these, add the "Sliders," which involve sliding from one mouth shape to another.

4. Sliders
   - /IE/ (as in ice)
   - /UE/ (as in use)
   - /OI/ (as in oil)
   - /OW/ (as in owl)

Consonants

There are eleven categories of consonants. There are eight "quiet/noisy" pairs, in which each pair has the same mouth action but one sound is quiet (whispered) and the other is noisy (voiced). The whispered sound should be given first in each pair. There are also three other groups in this category for which some primary feature of the sounds is the same, and the label identifies that sameness. As with vowels, consonant sounds should be presented with exaggerated mouth actions.

- Quiet/Noisy Pairs:
  - Lip poppers: /p, b/
  - Tip tappers: /t, d/
  - Scrapers: /k, g/
  - Lip coolers: /f, v/
  - Tongue coolers: /th, th/
  - Skinny air: /s, z/
  - Fat air: /sh, zh/
  - Fat pushed air: /ch, j/
- Other Groups:
  - Nose sounds: /m, n, ng/
  - Wind sounds: /w, h, wh/
  - Lifters: /l, r/

Babbling

Babies babble spontaneously, producing repetitive CV syllables after enough play has occurred with isolated consonants and vowels. To increase the amount of babbling, feed back the syllables the baby has just produced. Pause to allow the baby to produce them again. To increase the variety of sounds used in babbling, feed back the sequence of syllables produced by the baby, but modify the last syllable. For example:

Baby: /ba,ba,ba/
Adult: /ba,ba,ba/
Baby: /ba,ba,ba/
Adult: /ba,ba,da/
Baby: (May just listen for a while before imitating changes.)

Some parents misinterpret participating in a baby's babbling as encouraging "baby talk." It is not. "Baby talk" is encouraging simplified mispronunciations of words (i.e., /boo/ for blue). Helping babies to extend and modify the babbling of syllables strengthens and enriches their experience with the building blocks of language.

Even deaf babies babble initially, but the babbling extinguishes after a period because

they do not experience the stimulation of the auditory feedback. However, when mirrors are hung over their beds so that they get visual feedback from their mouth movements, they continue to babble longer. Because of the crucial importance of early intervention for deaf and hearing-impaired babies, a coalition of 20 organizations capped a 9-year effort and attained passage of the "Newborn and Infant Hearing Screening and Intervention Act" by Congress in November 1999. This landmark legislation specifies that three federal agencies will work together to develop, expand, and link statewide screening programs and intervention services so that every newborn in America will be screened for hearing loss and will have access to intervention (Boswell, 2000).

Single Words

Naming

As with the previous sensory input, babies need to experience naming input receptively for a period before they begin to name things in expressive output. Table 1 illustrates the differences between the receptive and expressive levels of naming. In naming, include single-word verbs and adjectives as well as nouns so children learn to name features and actions as well as things. For example, name the banana you are about to share, but also name what you do with it: peel, bite, chew. Use single words for what it is like: sweet, good. Also, use synonyms to give exposure to more than one name for something. In this way, children are stimulated with single-word language that they soon use. This emphasis on providing stimulation with single words will not deprive children of exposure to the language they will use eventually because phrases and sentences are receptively stimulated whenever others are conversing around them. Exaggerate the final consonants in pronouncing words. Children perceive initial consonants earlier than final consonants unless the final consonants are given extra attention. When possible, hold objects being named next to your mouth to permit the child to synchronize the auditory and visual input. When saying words ending in the plosive sounds /p, b/, /t, d/, /k, g/, or /ch, j/, say the words against the child's hand so the exploded air can be felt, since it cannot be seen. Again, this permits a synchronized experience with the auditory and kinesthetic input and increases the sensory experience with the words.

Phrases and Sentences

In developing a child's phrases and sentences, use gesture to pantomime actions, size, shape, or movement when possible to provide visual images for the meaning of phrases and sentences. Synchronize these meaningful gestures with language. Verbalize about your activities: what you are doing, what you are noticing, what you are thinking. Table 2 illustrates the differences between the

Table 1. Receptive and Expressive Levels of Naming

Receptive Level	Expressive Level
Hears own name, looks at self in mirror	Names self
Touches body part named	Names body parts
Points to people named	Names people
Points to objects named	Names objects
Does actions named	Names actions to manipulate environment

Table 2. Receptive and Expressive Levels in Phrase and Sentence Use

Receptive Level	Expressive Level
Complies with noun/verb or noun phrase request	Uses noun/verb or noun phrase to manipulate environment
Complies with sentence request	Communicates with sentences

receptive and expressive levels in phrase and sentence use.

The suggested progression will assist the development of speech-language in three important ways. First, by starting at the sensory level to stimulate conscious awareness of the distinctive motor-kinesthetic, visual, and auditory features of phonemes, a child will develop phoneme awareness. Second, this progression also provides a strong support base for the later development of written language. Phoneme awareness has been documented in worldwide research as the best single predictor of success in acquiring written language skills (Shankweiler and Liberman, 1989). Third, stimulation of images for the meaning of words and the ideas expressed by language increases comprehension of oral and written language. Individuals with strong imagery for words have the benefit of dual coding of language (Paivio, 1996).

REMEDIATING DELAYED LANGUAGE DEVELOPMENT

Oral Language Delay

What if oral speech-language development is obviously delayed? It is not uncommon for pediatricians to tell parents who are concerned because their 3-year-old does not have intelligible speech to relax—that their child may just be a "late bloomer." There are many reasons to take preventive action instead, primarily because speech-language delay also causes problems in several other areas of development. Therefore, it would be highly desirable for pediatricians to lead in preventive action. Speech-language stimulation can be light and fun for both the person providing the stimulation and the one receiving it. Pediatricians could arrange with speech pathologists to teach parenting groups the art of enjoying vocal play with their babies, starting very early and then continuing through the progression of language development just described. From the field of behavioral psychology, the research of Hart and Risley (1996) strongly supports preventive action. In a 2½-year longitudinal study, they observed 42 families for an hour each month to learn what typically went on in homes with 1- and 2-year-old children learning to talk. They report that the most important difference among the families was the amount of talking that went on within five categories of quality features: language diversity; proportional amounts of feedback tone providing encouragement and discouragement; emphasis on names, relations, and recall; an interactive style focused on asking rather than demanding; and responsiveness stressing the importance of the child's behavior during an interaction.

In extrapolating from their observational data, Hart and Risley found significant differences in the amount of talking related to socioeconomic status (SES) differences. In a 100-hour week, the average child in the professional families was provided with 215,000 words of language experience, whereas the average child in a working-class family was provided with 125,000. The average child in a

welfare family was provided with 62,000 words of language experience. A reverse pattern emerged for SES differences related to children's hourly verbal encouragements versus discouragements from parents. In professional families, the average child accumulated "32 affirmatives and 5 prohibitions per hour, a ratio of 6 encouragements to 1 discouragement." In working-class families, the average child accumulated "12 affirmatives and 7 prohibitions per hour, a ratio of 2 encouragements to 1 discouragement." In welfare families, the average child received "5 affirmatives and 11 prohibitions per hour, a ratio of 1 encouragement to 2 discouragements" (Hart & Risley, 1996, p. 199). Extrapolating these weekly and hourly differences to estimate differences in children's cumulative verbal experiences makes it easy to understand why these differences "were strongly linked to differences at age 3 in rates of vocabulary growth, vocabulary use, and general accomplishments, and strongly linked to differences in school performance at age 9" (Hart & Risley, 1996, p. 193). Hart and Risley point out that daycare providers and parents need specific training if they are to help close the gap for lower SES children. It is clear from these data that it is vital to have well-planned and funded intervention to help parents and other caregivers understand the critical effect on children's speech-language development of the amount of time spent talking with them, the importance of an encouraging tone of voice, and why this input must begin in the infant years.

However, the number of single words that a child recognizes and uses is not in itself a guarantee of language comprehension when those words occur in sequence to express ideas, requests, and questions. The ability to create visual images for the gestalts being expressed by language is an additional processing level that must not be taken for granted. The problem is less likely to be recognized as a lack of imagery for language, and is often thought to be related to less intelligence or a problem in paying attention. Fortunately, in our experience we have found the ability to create visual imagery for language can be directly stimulated with special procedures, with life-enhancing effects. (See Bell, Chapter 25, this volume.)

Written Language Delay

What if written language development is delayed, not only in first and second grade when children are first learning to read, but through middle and secondary schools and into adulthood? Currently, the general guidelines that public schools work under require a child's reading skills to be 2 years or more below grade level before remedial services can be offered through Federal Title I funding. Compare this to a child having a physical illness. Would we require a child to be ill for 2 years before diagnosis and treatment could be provided? Research has shown that the lack of phoneme awareness is the primary cause of problems in learning to read, that it is a genetic tendency (DeFries, Fulkes, and Labuda, 1987), and that there is neurophysiological evidence that lack of phoneme awareness is related to brain structure and function differences. Given this information, is it reasonable then to require a child to endure this cause of an "illness" in learning to read for 2 years before treatment is officially considered appropriate? And, when medical treatment is offered to an ill child, would doctors offer the same treatment that did not work before? This is commonly the situation in educational settings when retention has been the solution to below-grade-level reading. Fresh thinking and action in the educational field are required to address reading difficulties.

Fortunately, more and more parents are becoming advocates for their children and are seeking out and demanding adequate intervention (Kantrowitz and Underwood, 1999). Unfortunately, when early intervention has not been provided or has not been successful, well-meaning but poorly informed educators, psychologists, and doctors may incorrectly advise parents that older students who are not reading well by middle-school age cannot be expected to overcome their problem. It is usually suggested that efforts must be directed instead toward making use of various compensatory strategies rather than pursuing intervention regarding the cause of the problem. Alternatively, individuals are often advised to pursue a livelihood that does not require reading. Is there such a thing today? On the basis of 30+ years of clinical and classroom experience, the author can say that age is not the issue in successful remediation of written language problems. The issue is that diagnosing and treating the cause(s) of the problem rather than the symptoms enables older as well as younger individuals to develop functional reading language skills.

What if it is the encoding/decoding aspect of written language that is delayed? As discussed earlier, lack of phoneme awareness can be predicted if encoding (spelling) and decoding (word attack and word recognition) are the problem. What if decoding is accurate, but comprehension of what is read is the problem? Lack of, or partial and indistinct images for the ideas expressed—a lack of concept imagery—is revealed when the problem is comprehension of written language rather than decoding. And again, the need can be addressed both developmentally and remedially.

Another way to describe these two problems is that they both involve difficulty with part/whole relationships, but from opposite directions. In lack of phoneme awareness, for example, the person perceives a spoken word as a whole and cannot accurately identify and sequence the individual parts that comprise it. In lack of concept imagery, the person gets bits and parts, but doesn't comprehend the wholeness or gestalt of the message. It is encouraging to report, however, that success can be expected in addressing these problems in part/whole relationships with special procedures.

INTERVENTION PROGRAMS

The brain only receives information through the senses, and two levels of sensory processing are important. The first level is speed and magnitude of processing. How soon and with what vigor does the brain register incoming sensory information? Electrophysiology measures provide some objective information about this, and more access to this level of measurement would provide information that could assist improvement in treatment procedures. The second level involves incoming information from the three primary senses (auditory, visual, and motor-kinesthetic). How does the brain consciously process and integrate information so that these three senses support and augment each other? How are these senses additionally integrated with language for the cognitive benefit of dual coding (Paivio, 1986)? Performance measures can provide information about this to determine the effectiveness of intervention procedures and programs.

Various interventions are effective in preventively and remedially developing this sensory processing and integration if they are used for the processing needs for which they were created. This is where the diagnostic evaluation makes its critical contribution. The battery of tests needs to be carefully chosen to

provide a variety of performance information. When that information is appropriately interpreted, the diagnostic evaluation will indicate the areas of intervention that are needed.

The next section describes the Lindamood-Bell intervention programs. Other technologies that facilitate language and motor function will be described in Chapter 24.

Lindamood-Bell™ Sensory-Cognitive Programs

Lindamood-Bell have developed intervention programs for five areas of learning need identified during the 30 years they have been engaged in diagnosis, clinical and classroom intervention, and research. The following sections describe these areas of learning need and the progression of small processing steps that must be developed through intervention. There is an important difference between most language intervention programs (including the technology-based programs described in Lindamood, Chapter 24, this volume) and the Lindamood–Bell programs described here. The difference is the degree to which sensory information is brought to a *conscious* level from the auditory, visual, and motor-kinesthetic modalities, made concrete, and integrated with language in a dual-coding support system. This approach enables both children and adults to "own" the sensory information and its relationship with language, and assists them in accessing both to crosscheck information. This process supports thinking and reasoning about relationships between parts and wholes involved in learning tasks.

To understand the development, structure, and interrelationship of Lindamood-Bell™ sensory-cognitive programs, again we return to dual coding theory: "Cognition is proportional to the degree to which images and language are integrated" (Paivio, 1994). Topping the array of research supporting this simple statement is a layer of our own experience as learners: for the things we know best, we have both sensory experience and rich and detailed mental imagery. This dual knowledge enables us to talk easily about our experiences, which enables us to think critically about them. That is how we know something and can reason about it even when the thing is not physically present: our images and language bring "it" into our central nervous system. For example, it is said that Native Americans in the far north have a very large number of words to describe snow. They have become aware of contrasts in the look, feel, sound, taste, and smell of snow that we more southern folks probably could not, at first, notice. They developed multisensory images of snow, they talked about and labeled their sensory awareness of differences in snow, and the labels captured and crystallized the sensory awareness. The sensory input/images triggered language, and the language strengthened the imagery. Noticing sensory contrast enables language, and language enables noticing. This reciprocal relationship between language and sensory-cognitive processing/imagery is the backbone of five sensory-cognitive programs developed at Lindamood-Bell Learning Processes®. Their descriptions follow.

Lindamood Phoneme Sequencing™ (LiPS™) Program

The discovery of the causal role of individual differences in phonemic awareness in producing differences in the development of reading skills is one of the most important findings in reading research during the last 20 years. As a result, however, educators must decipher the meaning of at least three now very familiar (but often misunderstood) phrases known as the PH terms: phonics,

phonemic awareness, and phonetic or phonological processing. The differences among these concepts tend to confuse many who are trying to learn how best to help students. Does phonics develop phonemic awareness or phonetic processing? Or both? Or neither? Which is the cart and which is a horse? And what is the other one? It doesn't help that publishers have sprung into action adding PH words on their boxes and in their catalogs, sometimes without making any appreciable changes in program content.

A simple understanding of these terms is of considerable help in understanding how various programs that address phonemes, phonics, and phonetic processing compare. Phonemic awareness is a sensory-cognitive ability to think about and manipulate sounds within words; it is an oral language processing function. Phonics is instruction about how letters represent sounds in our language; it is written language instruction. Phonetic processing is the ability to decode written words, and requires both phonemic awareness and phonics knowledge. Students can learn phonics information (the letter "p" says /p/, an "e" at the end of the word usually makes a vowel say its name) without phonemic awareness; but without phonemic awareness, they cannot do phonetic processing. They cannot apply their phonics knowledge about sounds and letters for fluent and accurate phonetic processing unless they can detect phonemes within words. Without phonemic awareness, students cannot detect decoding errors unless a disruption in meaning clues an error. In addition, without phonemic awareness, students cannot self-correct even when meaning does clue an error because they cannot determine the nature of their error. So, phonemic awareness is the horse and it pulls several carts: phonetic processing in reading and spelling, rhyming, and other phoneme-manipulation tasks such as elision and substitution. (Another horse that pulls the phonetic processing cart—symbol imagery—will also be discussed later in this chapter and in Chapter 25.)

The PH-word concepts provide background for categorizing the LiPS™ Program. It is truly a phonemic awareness program that also includes phonics instruction and application of phonemic awareness to phonetic processing in both reading and spelling. Before addressing letter symbols, the LiPS™ program engages students in discovering the articulatory gestures that differentiate phonemes so that they can use oral-motor feedback to concretize, track, and prove the identity, number, and order of phonemes in words. Second, LiPS™ engages students in a variety of "phoneme tracking" experiences that directly require application of the newly developed awareness of articulatory feedback. Then, as they learn the symbols that represent phonemes, students have only a half step to take into reading and spelling. Having already begun to sequence phonemes at a very concrete level, such as with mouth pictures, it is quite easy for students to grasp the logic of the alphabetic principle and the use of letters for sequencing phonemes. Also, all the instruction is delivered in a "discovery" format through the use of questioning techniques that connect students to sensory experiences in order to form concepts. In summary, LiPS™ stretches from a prereading level where phonemic awareness is developed, into single syllable, multisyllable, and contextual reading levels in which phonemic awareness and orthographic expectancies are applied.

Steps in the LiPS™ Program

The following steps comprise the key elements of the LiPS™ Program.

1. *Setting the climate*: Students are helped to understand what they will be doing and

why—learning to *feel* as well as see and hear speech sounds in order to make reading and spelling easier.

2. *Consonants:* Students discover how each of the consonant sounds are articulated and use that sensory information to organize them into pairs and groups. Simple, high-imagery labels are attached to each category (e.g., lip poppers /p, b/, tongue lifters /l, r/) to enable teacher and students to communicate clearly about sounds within words in subsequent steps. For example, "When you say /clap/, what do you feel last?"
3. *Vowels:* Here, too, students discover how the sounds are articulated, and use that sensory information to organize the sounds into mouth shape categories such as Smile, Open, Round, and Sliders.
4. *Tracking*: As soon as students have awareness of the articulatory gestures for a few consonants and vowels, they need to begin using their oral-motor awareness to track the identity and order of phonemes in spoken words. They learn to use mouth pictures to show what they feel first in a word, and what comes right after that, and so on. Figures 1 and 2 are examples of mouth picture tracking.

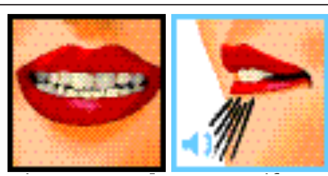


Figure 1. "Show me.../if/."

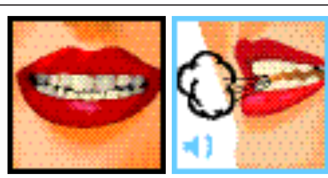
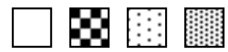


Figure 2. "That says/if/, now show me/it/."

Then, to move onward from this very concrete phoneme tracking, students use colored blocks to show sounds in the tracking task (see Figures 3 and 4).

Figure 3.
"If that says/snip/..."

Figure 4.
...show me/skip."



The labels (e.g., lip popper, tip tapper) are used as the teacher asks questions about what students feel and as students verbalize contrasts between words. Thus, phonemes are dual coded at each step with imagery and language.

5. *Decoding and spelling:* Tracking establishes a base for students to grasp the logic of coding speech sounds with letters. In decoding, "Since I see an 'L' right after the smile vowel, I will have to make my tongue do a lifter there." As phonetic processing emerges, orthographic expectancies are introduced so that students begin to integrate phonetic processing with an ability to predict how words will be spelled or read. Sight words also are stimulated so that students can progress simultaneously into fluent contextual reading and writing. Tracking, spelling, and reading are kept synchronized as work progresses through words with simple, complex, and multisyllable structures, in an age-appropriate format for the student.

The intensive, concrete, dual-coded processing stimulated in the LiPS™ Program makes it quite different from others labeled as phonemic awareness programs. Although various studies show training in phonemic awareness to be effective in helping students understand the alphabetic principle and develop independent word reading skills, research points to a common problem in that phonemic awareness training procedures may

not be powerful enough to aid students who are most at-risk for the development of reading difficulties. For example, both Torgesen et al. (1992) and Lundberg (1988) found that a significant number (20%-30%) of the least able students were unable to profit from their phonemic awareness training procedures. These students are not "missed" if phonemic awareness stimulation is very concrete, with sensory experiences captured by language, as in the LiPS™ Program.

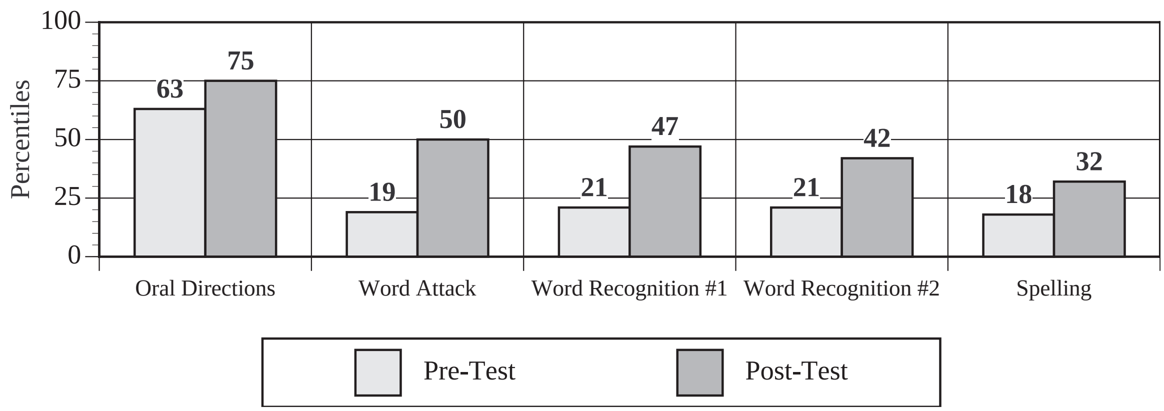
For example, Alexander, Heilman, Voeller, and Torgesen (1991) used LiPS™ (then called the ADD Program) with a group of severely reading-disabled students with an average age of 10 years, 9 months. They had been unable to benefit from either regular classroom instruction in reading or resource help with several different remedial programs. After 65 hours of clinical intervention, this group of 10 students improved from an average standard score of 77 on a measure of alphabetic reading skills to an average of 98.4 (standard score mean=100). The poorest reader in the group improved his standard score in reading from 62 to 92, which placed him in the average range. This group of students had begun treatment with an average score on a measure of phonological awareness of 57.9 (minimum score recommended for their grade=86), and had improved to an average score of 99.9 following treatment. Although these students had been unable to progress in reading instruction previously, their situation changed after the development of their phonemic awareness and its application to decoding. Dr. Joseph Torgesen, one of the principal investigators in this study, states that a subsequent report after follow-up testing during the next 2 years indicated "these students were continuing to gain in growth of sight word vocabulary and passage comprehension. To my knowledge, this is the first time we have observed a remedial study with older students severely impaired in reading ability documenting continued growth after the instructional intervention is over." (Personal communication with permission to quote.)

This significant effect for very at-risk students can also be seen in Lindamood-Bell™ clinical data on 76 students, randomly selected, who were seen individually for an average of 98 hours of LiPS™ combined with the Seeing Stars™ program (described later in this chapter). We routinely combine the two programs for students who have a severe lack of phoneme awareness because the Seeing Stars™ program develops students' ability to make mental images for sequences of letters. We have found the ability to create symbol imagery interacts with phoneme awareness, and results in more fluent decoding as well as better gains in spelling. The group, composed of 36% females and 64% males, ranged in age from 6 to 18 years, with a mean age of 10 years, 3 months. The average pre- and post-test gains in percentile rankings shown on the various measures indicated in Graphs 1A and 1B that follow were all significant at the $p<.05$ level.

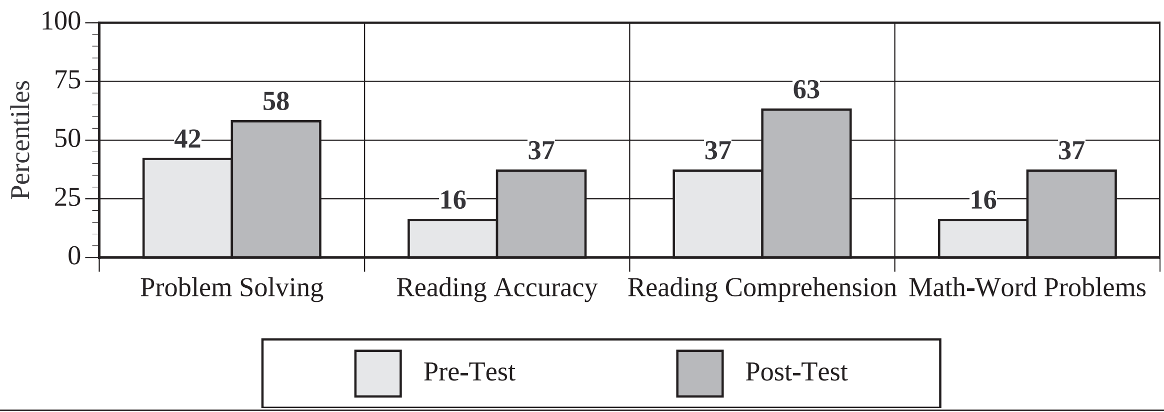
Several preventive studies using LiPS™ to stimulate phonemic awareness and its application to reading and spelling in kindergarten and first grade have demonstrated strongly positive results. There are three primary reasons for its success. First, LiPS™ can stimulate phonemic awareness for *all* students in a classroom setting, with highly significant effects on word attack, word recognition, spelling, and reading comprehension. Second, stimulating a conscious processing base of phoneme awareness is productive for students who are not high-risk for reading difficulty as well as for those who are. And third, early phonemic awareness stimulation with LiPS™ produces advantages in written language skills that continue into high school (Lindamood, Bell, & Lindamood, 1997b). We

Graphs 1A and B. Pre- and Post-Test Percentile Rankings on Various Measures for Students in a Combined Lips™ Seeing Stars™ Program

Graph 1A.



Graph 1B.



are beginning to gather data on the effect on spelling and fluency in reading of combining the LiPS™ and Seeing Stars™ programs to focus on integrating stimulation of phoneme awareness and symbol imagery. Initial trends appear to indicate this is a productive approach, but more data are needed before we can publish findings. The concern is that significant gains in spelling and reading fluency have consistently been less predictable than decoding gains after development of phoneme awareness and sequencing. It will be a contribution to intervention if we are able to document that there can be a better effect in those two areas if we directly stimulate symbol imagery along with phoneme awareness.

Visualizing and Verbalizing for Language Comprehension and Thinking™ (V/V™)

In contrast to the LiPS™ Program, which stimulates accuracy and self-correction in decoding and spelling, the V/V™ Program stimulates concept imagery to develop language comprehension and higher-order

thinking skills. Where LiPS™ develops students' ability to process the smallest parts of language, V/V™ develops students' ability to process gestalts of meaning, in which the whole is larger than the sum of the parts. The instructional procedures of the V/V™ Program are supported by dual coding theory; that is, visual imagery for language can produce powerful effects on the memorability and comprehensibility of sequentially presented material such as oral or written discourse. In the V/V™ Program, students are helped to discover that they can create visual images for single words, and can add more imagery to comprehend single sentences. They can then connect imagery for a first sentence to imagery for the next sentence and so on until a mental movie has captured an array of detail into a gestalt. The ability to create images is generally assumed in many comprehension programs, but the V/V™ Program actually helps students develop this ability where it is lacking (whether due to environmental or genetic influences, or both).

Many of the same discovery and questioning techniques that are employed in the LiPS™ Program are utilized by the V/V™ Program. This is because teachers cannot create sensory experiences for students by telling them information; teachers must ask questions that cause students to check and notice sensory experiences. Similar to the LiPS™ Program, the V/V™ process first addresses the sensory-cognitive function that underlies the skill students need to acquire. The horse in this case is concept imagery, which is the ability to create mental images for meaning of language, and the cart it pulls is language comprehension and expression. Vocabulary is also tightly related to imagery and comprehension, either as a second horse or second cart, depending on how it is conceptualized. Perhaps vocabulary should be pictured as the harness connecting the horse to the cart, connecting imagery to comprehension.

(For further discussion of the V/V™ process, see Bell, Chapter 25, this volume.)

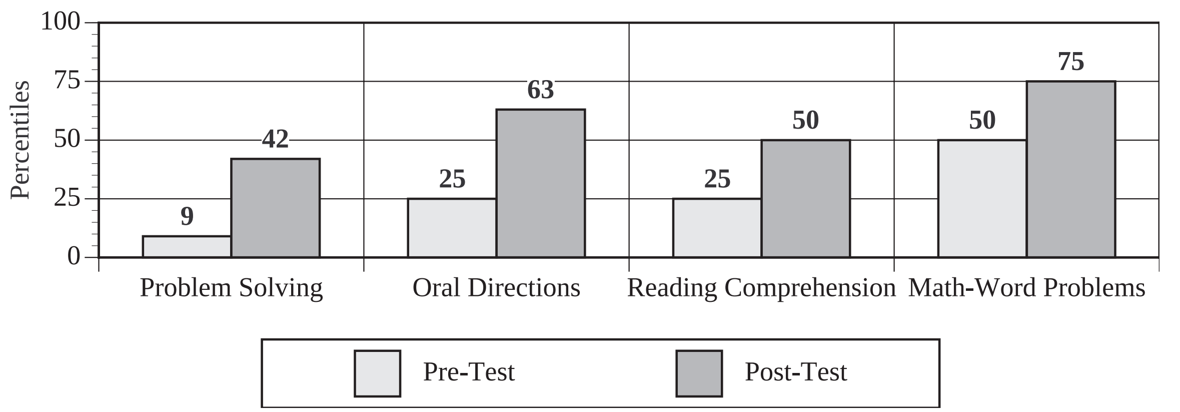
Steps of V/V™ Program

The following steps make up the key elements of the V/V™ program.

1. *Setting the climate:* Answers the questions of, What is the teacher's job? What is the student's job?
2. *Picture to picture:* Develops students' ability to verbalize about given pictures before they verbalize their own mental images.
3. *Word imaging:* Develops detailed imagery for the meaning of single nouns.
4. *Sentence-by-sentence imaging:* Begins developing an imaged gestalt as detailed imagery is added and changed sentence by sentence through a paragraph.
5. *Sentence-by sentence-imaging with HOTS (Higher-Order Thinking Skills):* Begins stimulating students' ability to use imagery for main idea, inference, conclusion, and prediction.
6. *Multisentence imaging:* In steps 5 through 8, students gain experience in capturing increasingly larger amounts of language in their imagery.
7. *Paragraph imaging.*
8. *Paragraph-by-paragraph imaging.*
9. *Whole-page imaging.*

Graph 2 shows clinical data for 58 students, randomly selected, who were seen individually for an average of 96 hours of V/V™. The group, composed of 53% females and 47% males, ranged in age from 6 to 47 years, with a mean age of 14 years, 7 months. Pre-and post-test average percentile gains on all measures indicated were significant at the $p<.05$ level of confidence.

Graph 2. Pre- and Post-Test Average Percentile Gains on Various Measures by Students in a V/V™ Program



We have used V/V™ with many high-functioning autistic/autistic spectrum students. Although autistic students are often thought to have strength in visual processing and visual-spatial imagery, it is our clinical experience that there tends to be a significant weakness in connecting images to language and language to images. In other words, dual coding tends not to occur for autistic students. However, "tends not to occur" does not mean "will not occur" for students. In applying V/V™ with students in our clinics, it has been our experience that dual coding can be stimulated even for students on the autistic spectrum, with measurable improvement in language comprehension and expression.

Temple Grandin, a high-functioning autistic individual who is a professor of animal behavior and also a celebrated author, speaker, and researcher on autism, has analyzed her own problems with language. Her description of how she specifically has to assist herself to express her thoughts with language is remarkably similar to the imagery process Bell (2000) has developed, which has successfully assisted autistic as well as nonautistic individuals to improve their receptive and expressive language (see Bell, Chapter 25, this volume). Grandin reports, "In my brain, words act as a narrator for the visual images in my imagination… When I am talking about something for the first time, I look at the visual images on the 'computer monitor' in my imagination, then the language part of me describes those images" (Grandin, 2000, p. 14). She describes this occurring as two separate steps for her, but believes they occur "merged into one seamless consciousness" for most people. Her assessment is striking because early in the V/V™ progression we see this two-step processing occur, but we also see the two-step process merging into one process as treatment is continued. The question in our minds is "Would this merging of images and language occur and become seamless for Grandin if we took her through the small steps of processing in the V/V™ Program that enable the merged processing to develop?"

Grandin also verifies our clinical observation that autistic spectrum individuals tend to give more attention to details or to parts and miss the big picture, the whole or gestalt. Grandin states, "I look at lots of little details and piece them together to make a concept." (Grandin, 2000, p. 18). She has figured out how to serve her comprehension needs by consciously making use of her inclination to

give attention to details. However, autistic spectrum students in general need to be directly helped to discover they can do this to create an imaged gestalt for comprehension of spoken or written language.

Seeing Stars™: Symbol Imagery for Phonemic Awareness, Sight Words, and Spelling

Seeing Stars™ is Lindamood-Bell's "other" imagery program. Compared to Visualizing and Verbalizing™, it addresses what we call "the other side of the coin": not the ability to image the meaning of language but the ability to image the orthography of language, the letters and letter patterns of the written language. In her imagery chapter, Bell (Chapter 25, this volume) presents considerable evidence for the role of symbol imagery in phonemic awareness, spelling, word attack, word recognition, and fluency. She reports strong correlations between performance in these areas and imagery for letters in words. More important than the existence of symbol imagery as a sensory-cognitive process and its relationship to written language processing is that symbol imagery can be stimulated. Even more important, stimulating symbol imagery produces significant gains in phoneme awareness, decoding, spelling, and reading in context.

The steps of Seeing Stars™ stretch from imaging single letters, to imaging simple syllables (such as /if/, /fip/, and /cab/), to imaging complex syllables (such as /ask/ or /streak/), to imaging multisyllable words, to using imagery to learn specific sight words and spelling words, and on to applying symbol imagery to reading in context. Each step includes specific symbol imagery exercises such as naming requested letters (e.g., "What letter do you picture after the r?"), decoding the imaged word (e.g., "The word you're picturing says …?"), and manipulating the image and decoding again (e.g., "Take out the T—what letters do you picture? So that says …?")

Classroom findings indicate that these steps are very appropriate for students just beginning to learn about sounds and letters because symbol imagery instruction strengthens phoneme awareness and phonics instruction. For example, after observing early indications of a future phonemic awareness problem in her own daughter at 2 and 3 years of age, Phyllis Lindamood offered articulatory stimulation coupled with symbol imagery stimulation (LiPS™ and Seeing Stars™) in a light and lively fashion. This could be quite manageable for many parents, and could prevent some early failure experiences for children, as it seems to have done for Phyllis's child.

Symbol imagery stimulation impacts far more than sound/symbol associations; we have shown its effects beyond phonics knowledge on phonemic awareness and phonetic processing. When teachers stimulate both articulatory feedback and symbol imagery for students, the students' grasp of the alphabetic principle is strong, and their reading and spelling performance is significantly strengthened. Students and teachers then have a very concrete sensory reference for the elusive phonemes within words (articulatory feedback) as well as a rapid visual-sensory reference (symbol imagery). Thus, when they need to, students can do slow and careful phonetic processing using articulatory feedback and, using symbol imagery, can shift to the faster processing that fluency requires. Even when teachers do not develop students' use of articulatory feedback to concretize phonemes, symbol imagery can serve a concretizing function that supports phonemic awareness and phonetic processing. (See Bell, Chapter 25, this volume, for more detail on symbol imagery.)

Steps of the Seeing Stars™ Program

The following steps are key elements of the Seeing Stars™ Program.

1. *Imaging letters:* Stimulating sound/letter relationships and imagery for consonants and vowels.
2. *Syllable cards:* Stimulating the ability to image a word from a model (a card with a word on it) and decoding/encoding for single-syllable words using orthographic expectancies.
3. *Syllable board:* Generating symbol imagery from a spoken word (whole to parts) or spoken letters (parts to whole). Students also get motor-kinesthetic input at this step as they finger-write on a hard surface.
4. *Imaging syllables with and without a chain:* Stimulating symbol imagery and decoding/encoding for single syllable words.
5. *Imaging sight words:* Establishing visual memory and instant recognition.
6. *Imaging spelling:* Establishing visual memory for orthographic expectancies and real-word spelling.
7. *Multisyllable reading, spelling, and imagery:* Decoding/encoding imaging of affixes, use of multisyllable syllable cards, multisyllable syllable board, and multisyllable reading and spelling of real and nonword lists.
8. *Contextual integration:* Applying word attack and word recognition skills to contextual reading, with symbol imagery to print-comparing stimulated for rapid self-correction.

Vanilla Vocabulary

Vocabulary development is, appropriately, a major concern for those trying to help students with learning difficulties. A good vocabulary does not result in good comprehension and reasoning, but a weak vocabulary will limit comprehension, reasoning, and communicating. Teachers at every grade level see this issue in action: students who can decode words that have no meaning for them, or the difficulties of teaching new concepts when students have terrible gaps in basic vocabulary. Although teachers may be well aware of their students' vocabulary needs, when asked how they help students develop vocabulary they typically talk about their frustrating search for tools and how little effect their efforts have.

It is the premise of the *Vanilla Vocabulary* program (Bell & Lindamood, 1993, 1998), that studying words—an unfamiliar word and more unfamiliar words to define it—often does not result in significant vocabulary growth because it does not result in dual coding. Unless words are tightly integrated with the sensory input of imagery, they tend not to become a part of one's functional vocabulary. Vocabulary drills often make individuals familiar with a word in terms of having heard it but do not stimulate enough imagery to enable use of the word in speaking or to gather complete meaning when listening and reading. Stimulating vocabulary with concept imagery (dual coding) is really quite straightforward with the structure that *Vanilla Vocabulary* provides. Beginning level (Book 1) and intermediate level (Book 2) words are defined by using high-imagery language to enable dual coding. For example, compare an "American Heritage School Dictionary" definition with a *Vanilla Vocabulary* definition:

- *Dictionary:* **illusion** – an appearance or impression that has no real basis, i.e., creating the illusion of depth in a painting.
- *Vanilla Vocabulary:* **illusion** – something that seems to be real, but is not. "The castle towers appeared higher than the clouds but it was only an illusion."

The *Vanilla Vocabulary* definition is created to provoke imagery. The high-imagery definition is followed by three simple, but high-imagery sentences for students to visualize using the new word. Many dictionaries do not provide sentences to further illustrate the meaning of words. It is not assumed that students will form an image just because *Vanilla Vocabulary* definitions and sentences are "high imagery." Teachers are directed to question students about what they are picturing, using choice and contrast to develop vivid, personal imagery. Then, students visualize and verbalize to create their own sentence using the target word. As students master the new vocabulary by visualizing and verbalizing, there are companion books intended for reading aloud which use the target words again in humorous, high-imagery stories titled *Ivan Sleeps Over* and *Ivan, King of the Neighborhood* (Bell & Lindamood, 1997).

On Cloud Nine™—Visualizing and Verbalizing for Math

While the sight words versus phonics versus whole language wars raged in the field of reading, the manipulatives versus memorization wars raged in math. Manipulatives have been used for years in teaching math (Stern & Stern, 1971), but many individuals who experienced success with this most concrete level failed in the shift to computation (Moore, 1990; National Council of Teachers of Mathematics, 1989; Papert, 1993). Some students could think logically in problem solving but couldn't seem to memorize the math facts that enable rapid processing. Others could memorize facts but couldn't seem to reason with those facts in word problems.

At Lindamood-Bell™, as we looked at students struggling with math, we saw the same critical sensory input/imagery/language link that had resulted in solutions for students with decoding and comprehension problems. The missing link in the math wars seemed to be imagery: concept imagery and numeral imagery at a conscious level. Students who are not imaging do not leave behind the manipulatives and move on to mental imagery so that they are able to do mental manipulations with numbers. For individuals to grasp math concepts, reason with numbers, and compute accurately, concept imagery and numeral imagery are critical sensory-cognitive precursors.

The On Cloud Nine™ math program moves through the following three basic steps to develop mathematical reasoning and computation:

1. Using manipulatives to experience the realness of math.
2. Using imagery and language with those manipulatives to concretize the realness in the sensory system.
3. Using numeral imagery and concept imagery to apply computation to word problems.

The following specific steps illustrate how the program links sensory experience to language to concept imagery to numeral imagery. The goal is dual coding in math.

Steps of the On Cloud Nine™ Program

The steps of the On Cloud Nine™ Program begin with *setting the climate,* and proceed according to the increasing difficulty of number concepts, as follows:

1. *Imaging numerals*
2. *Imaging the number line*
3. *Addition family facts*
4. *Subtraction family facts*
5. *Word problems*
6. *Place value*
7. *Jumping*
8. *Carrying and borrowing*

9. *Multiplication*
10. *Division*
11. *Decimals*
12. *Fractions and a "step-ladder"*

Drawing With Language™

Because some individuals have adequate visual-motor processing, they easily think about and generate "drawings." (By "drawings," we mean anything where lines and space create a figure. A drawing is not just artistic pictures such as nudes and still lifes, but letters and numbers, maps, diagrams, geometric figures, and such.) But some individuals, especially young children, have difficulty processing visual-spatial relationships—the whole and the parts. These difficulties can persist beyond the developmental norm, causing individuals to have difficulty with print and handwriting, copying from the board, organizing work on the page, and interpreting graphically presented information. Based on the number of individuals referred to our clinics, those with weak visual-motor processing as the primary difficulty seem to comprise a smaller group than those with weak decoding or comprehension. Alternatively, perhaps educators and parents tend to view weak visual-motor processing as less of a problem and so are less concerned about it.

The fact that fewer students are referred for "difficulty in drawing" than for difficulty in reading does not diminish the very real and negative effects for students. Although individuals certainly vary in the fine motor coordination needed to grip a pencil and generate a line, this variation does not account for the difficulties regularly seen as weak visual-motor processing. For example, Cody, a high school student, made many "careless errors" in math due to numeral misalignment and poor legibility, and often lost his way in unfamiliar physical environments. He could form single lines in any direction, but had extreme difficulty recalling and drawing lines in relationships in even fairly simple figures, such as that shown in Figure 5, the Detroit Test of Learning Aptitude, Design Reproduction Subtest. The stimulus figure is shown for a specific number of seconds, then removed and the individual draws the figure.

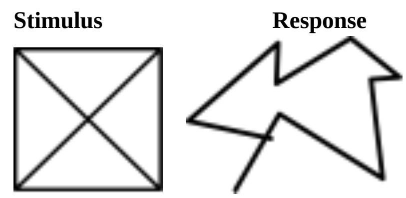


Figure 5. Comparison of Stimulus and Student Response in a Design Reproduction Subtest

In our clinics, we have found that connecting language to sensory input/imagery is as effective with visual-motor development as with the other sensory-cognitive functions we address. We see significant improvement for students such as Cody through what we call our Drawing with Language™ Program. This program stimulates an individual's ability to:

– *verbalize* the units and relationships involved in drawings, and
– *visualize* those units and relationships as a mental model from which to compare and reproduce them.

Steps of the Drawing with Language™ Program

The following steps are key elements of the Drawing with Language™ Program.

1. *Setting the climate*
2. *Collecting language for drawing*
3. *Learning three kinds of lines*
4. *Line-by-line production: verbalize-visualize-draw*
5. *Shapes*
6. *Designs and symbols*
7. *Drawings*
8. *Application*

In early steps, students learn to use language to create a mental image, compare what they drew to the model, and describe exactly how and where corrections need to be made. Although comparing a drawing and a model point by point can be a slow process, it is this ability to compare a stimulus and a response that results in self-correction. As verbalizing becomes more automatic and internalized, it becomes the inner language that the frontal cortex uses to direct the members of the orchestra—the visual and motor cortices. As visualizing becomes more automatic, imagery becomes the means of comparing drawing to model, a much more rapid process. As with other Lindamood-Bell™ programs, the goal is to address sensory-cognitive functions so that a person develops *independent* and, ultimately, *rapid and automatic* self-correction and accurate processing.

Programs and Technology

CD-ROMs are presently available for the LiPS™ and V/V™ programs, and the other programs are targeted for future CD-ROM support. Through careful planning, the technology contains interactions that border on artificial intelligence in providing feedback on error responses. This means technology can provide additional problem-solving practice that furthers the development of dual coding and rapid, automatic sensory-cognitive processing.

CONCLUSION

This chapter has presented issues in the prevention and remediation of problems in oral and written speech-language development. It also has included ways that can be used either preventively or remedially to approach problems in math and visual-spatial cognition because of the interactive roles of sensory processing and language in these areas of learning as well.

An over-arching theme in this chapter was the issue of parts/wholes relationships in sensory-cognitive processing. Our clinical experience at Lindamood-Bell™ makes us wonder if satisfying three conditions might enable us to teach virtually anyone virtually anything. These conditions are:

1. If we are able to identify, label, and experience the *units* involved concretely enough at the sensory level to bring them to consciousness.
2. If we use the labels, sensory information, and language to track and compare the *relationships* of the units.
3. If we think and reason together about how the units and relationships combine to create and form the *whole* that is greater than the sum of the parts.

A secondary theme in this chapter was the evidence that there is sufficient research to drive practice in some of these areas of learning needs. Does this mean we shouldn't explore the use of emerging preventive and remedial practices until definitive research is available on their efficacy? The answer to that question is "No." We can use emerging practices so long as they cannot harm children and there is a body of anecdotal support for their positive effect. Recent developments in technology are now making it possible for medical research and clinical practice to complement each other. Pilot findings from beginning efforts to look at brain functions pre- and post-Lindamood-Bell™ treatment indicate there may be information from fMRI and electrophysiology measures documenting that appropriate stimulation enables brain functions to become established or improved. These measures, analyzed in combination with performance measures, give hope of further progress

in meeting the need for oral and written communication for more children and adults.

We will soon conduct research aimed at answering the many questions that remain relative to management of intervention. It is our expectation that sorting by age groupings, severity of processing deficits, intensity of treatment (4 or more hours of daily intervention compared to the more common 1 hour), and single areas of processing need compared to two or more will generate information that will lead to better prognosis and treatment recommendations.

Being (and feeling) competent in communicating through either oral or written language is a base upon which a person can manage the rest of life's demands. If we, as therapists, provide intervention in these areas we should never be satisfied with just our current efforts. Nor should we be isolated in our efforts. As discussed further in the next chapter, our goal should be to strive toward advances that we know may be possible through research on combining intervention programs—rather than through research that *compares* intervention programs. Such research should be with programs in our own field as well as with programs of other disciplines in the team effort needed. ■

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